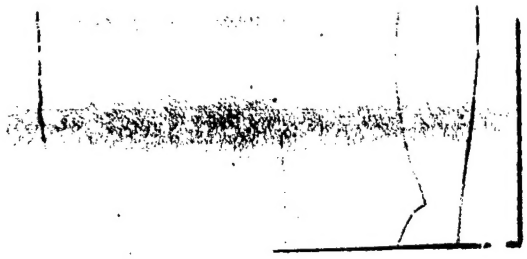

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CONFERENCE DEVOTED TO PROBLEMS CONCERNING THE APPLICATION OF RADIOELECTRONICS IN MEDICINE AND BIOLOGY (USSR)

[Translation]

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/Translation/

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V. G. Yasnogorodskiy

A conference was held in Moscow on 5-10 January 1959, which was organized by the Scientific-Technical Society for Radio Engineering and Electrocommunications Imeni A. S. Popov, the All-Union Scientific Council for Radiophysics and Radio Engineering of the USSR Academy of Sciences, the State Committee for Radioelectronics under the Council of Ministers of the USSR, the USSR Ministry of Public Health and the USSR Academy of Medical Sciences. A total of 380 physicians, physiologists, biophysicists and engineers working in the field of radioelectronics took part in the conference. A wide variety of problems were discussed, since this was the first conference concerned with the application of radioelectronics in biology and medicine. For this reason, the conference was divided into two plenary sessions, four combined sectional meetings and eight sectional meetings comprising the following sections: clinical medicine, physiotherapy, labor hygiene, and experimental biology and medicine. A total of 58 papers were read at the conference.

In opening the conference, Academician A. I. Berg, Chairman of the All-Union Scientific Council for Radiophysics and Radio Engineering, noted that the purpose of the conference was to effect a better utilization of present achievements of physics and radio engineering in the fields of biology and medicine. He called upon engineers and radio amateurs to engage in the design of medical instruments and equipment, and to work in close collaboration with physicians, since only under such conditions can the design of modern instruments, useful in the medical and biological field, be accomplished. He reported that a

special section concerned with the application of radioelectronics in the medical field was organized under the Scientific-Technical Society Imeni A. S. Popov, and called upon participants at the conference to take an active part in the work of this section.

Academician Prof. V. V. Parin, Secretary of the USSR Academy of Medical Sciences, in his report entitled "Problems Confronting Radioelectronics in the Fields of Medicine and Biology," examined certain trends in the application of radioelectronics, concerned with the most important problems in experimental and clinical medicine. In particular, he noted that various instruments for the application of stimulations (stimulators) are widely used in physiology and experimental medicine, and that a study of bioelectric phenomena is conducted on a large scale; a wide variety of bioelectric processes can be recorded simultaneously, and that, in conjunction with a micromanipulator and stereotoxic instruments, it is possible to record the biocurrents of individual nerve cells and even of their component parts. The application of radioelectronics makes it possible to measure and to record various non-electric physiological processes. The piezoelectric, tensometric, capacitive, electromagnetic, photoelectric and other types of data units (pickups), which are used for this purpose, can be used to measure the temperature, the pressure of pulse beats, in oxyhemometry and electrocalorimetry, in measuring the pH of circulating blood, and also in the recording of other biochemical phenomena.

In the clinical medicine field, radioelectronics contributed to the development of such new diagnostic methods as kymophonocardiography, electromanometry in conjunction with heart catheterization, ballistocardiography, hemodynamocardiography, rheography, ultrasonic diagnosis, and the examination of patients under natural living and working conditions (with the aid of radio transmission of information on physiological functions). The potential application of X-ray examination is being considerably expanded. In the prosthetic field, a lack of vision during reading may be partly compensated by converting light signals into acoustic signals. Methods involving the biolectric control of prostheses are under development. High-frequency currents are widely used in surgery for the coagulation and cutting of tissues. Radio engineering devices are most extensively used in physiotherapy, where electric currents and their manifestations in the form of electric and magnetic fields are finding a wide variety of applications.

In conclusion, Prof. Parin noted that in spite of certain progress in the development of electric medical instruments, our country is still lagging behind a number of foreign countries from a quantitative and qualitative standpoint. A lag is particularly noticeable in comparison with the development of electronics in other Soviet branches of science and technology. An enormous discrepancy in time can be observed between

the design of experimental models and their serial production. Along with the output of high-quality and unique equipment, long outdated models continue to be manufactured on an industrial scale. In order to correct this situation, Prof. Parin suggested that a more extensive use should be made of such modern technical facilities as telemetry, semiconductors, new recording instruments, automation equipment and electric computing devices. He also pointed out the necessity of raising the technical qualifications of scientific medical workers and enlisting the services of engineering and technical personnel in medical scientific-research institutes and therapeutic establishments.

P. V. Gusenkov, Deputy Minister of Public Health of the USSR, also noted the presence of a considerable lag in the design of various types of diagnostic and therapeutic equipment, and pledged that the Ministry of Public Health of the USSR would take all the necessary measures to correct this situation.

Prof. A. N. Obrosov, corresponding member of the USSR Academy of Medical Sciences, in his report entitled "Basic Trends in the Application of Electronics in Physiotherapy," noted that electronic circuits are now being used in Soviet electrotherapeutic and electrodiagnostic equipment. However, inadequate use is still being made of the enormous potential afforded by radioelectronics in improving the quality of equipment, expanding its potential therapeutic applications and designing new equipment. The application of modern electronic means in this field should be expanded in the following directions. In the field concerned with therapeutic applications of pulse currents, a very urgent problem is the design of pulse current generators with a pulse frequency of 1 to 1,000 cycles per second, which would cause the interference of two similar currents in the tissues of an organism. Another pressing problem is the design of therapeutic equipment capable of exerting a mechanical pressure on tissues and vessels according to the rhythm of physiological processes, for example, in accordance with the functioning of the heart or lungs. Also promising would be the design of equipment which could reproduce currents modulated by the biopotential of muscles, of the heart, and of other organs.

In the field of therapeutic application of high-frequency electromagnetic oscillations, it is necessary to design the following types of equipment:

a. Generators of high-frequency oscillations (13.56 megacycles, with varying output power, including portable-type generators), which would yield a therapeutic effect caused by the application of an alternating magnetic field to small sectors of the body of varying configuration.

b. Generators of super-high frequency oscillations, corresponding to centimeter and decimeter waves, capable of operating both under constant and pulse operating conditions.

c. Generators of an uhf pulse field, with wide variations in the parameters of electromagnetic oscillations.

d. Generators of millimeter and centimeter waves.

e. Equipment allowing the therapeutic use of supersonic vibrations, capable of operating both under constant and pulse operating conditions.

Prof. Obrosov's report emphasized the need for more intensive work on the design of equipment used in physioprophylactic applications, particularly of group and individual air ionization units, of air ionizers operating in combination with a high-voltage electric field, of units capable of creating an artificial climate in premises, of sunlight lamps and equipment used to induce electric sleep. He also pointed out the necessity of designing instruments capable of measuring the energy of high-frequency oscillations, which is absorbed in the body of patients, of instruments measuring the dosage of ultra-violet and infra-red rays, of counters for light, medium and heavy aeroions.

In the field of protective (safety) measures, attention was drawn in the report to the necessity of providing physiotherapeutic equipment with reliable, low-cost and easily operated devices capable of preventing the radiation of interferences from the equipment, and also capable of providing measuring and diagnostic equipment used in therapeutic establishments with an effective protection against interferences.

Prof. N. M. Liventsev described the action of low-frequency pulse currents and the relation between response mechanisms of the organism, particularly of the neuromuscular system, and different current parameters. In his report, he pointed out that amplitude and frequency modulation of pulse currents are being studied at the present time and are finding partial application in therapeutic practice. However, in order to facilitate the study of the possible therapeutic application of currents modulated in this manner, it is necessary to use complex radio engineering circuits and to design universal pulse current generators, which would allow to conduct research within a wide range of various current parameters, and also to design a number of devices for the visual control and measurement of pulse current parameters. In order to study the effect upon the organism of currents exerting the same action as biopotentials, it is necessary to design corresponding amplifiers and generators, as well as generators capable of reproducing currents of any given periodic or aperiodic shape.

Engineer I. K. Taborovskiy described the presently available equipment used for electric stimulation purposes, among which the following types of equipment are manufactured in series for clinical diagnostic purposes:

a. The KED unit, used in classical electric diagnosis, which makes it possible to determine the electric excitability during the action of galvanic and tetanizing (faradic) currents.

b. The EI electric pulsator, for determining galvanic electric excitability, chronaxy and lability.

c. The ISE pulse electronic stimulator, similar to the EI unit.

Further therapeutic equipment manufactured at the present time include a unit for muscular stimulation (ASM unit) and an electronic respiratory stimulator (ESD unit).

Among the experimental equipment used for general-purpose stimulation, the following individual models of equipment are manufactured: the US-1 general purpose (universal) stimulator, used in experimental work in the field of central neurosummation; and the GRAKh-1 simplified general purpose stimulator for determining the galvanic excitability, chronaxy, lability, accommodation properties of stimulated tissues and of the most simple summantion elements.

The speaker then described the operating principle and the potential field of application of the GRF generator of various current forms, built at the All-Union Scientific Research Institute of Medical Instruments and Equipment (VNIIM i O). This quite complicated unit is capable of generating pulses, the shape of which varies within a wide range; with the aid of this unit, it is possible to obtain a series of both single (isolated) pulses, as well as of pulses recurring periodically at definite and controlled time intervals. Within the range of the pulse series, it is possible to effect the modulation of the pulse repetition rate and of the pulse height according to any law desired.

Candidate of Medical Sciences V. G. Yasnogorodskiy pointed out the present small discrepancy between the potentialities afforded by modern radioelectronics and the present status of high-frequency equipment, and examined the problems which still remain actually and technically unsolved, and which thus lower both the efficiency and potential therapeutic application of high-frequency methods. In particular, he noted that the manufacture of equipment used in local darsonvalization has been completely stopped at the present time, only because such equipment creates radio interferences. At the same time, darsonvalization is a very effective and widely used method of treatment. In order to preserve

this method, it is necessary to find convenient and effective means for suppressing interferences caused by this type of equipment. In order to allow a more extensive application of inductothermy (inductive thermal methods of treatment), it is necessary to design electrodes and equipment capable of exerting an effect on small limited sectors of the body and on body sectors with an irregular (rough) surface. The design of low-power equipment for the same purposes is also indispensable. It was noted further that the lack of objective dosimetric methods is at present the weakest spot in high-frequency therapy. This is particularly the case in the UHF electric field and inductothermy, where only the output power of the equipment can be measured, whereas the problem of determining the amount of energy absorbed by the body of the patient has not yet been solved even in principle.

The speaker mentioned the dissatisfaction expressed by physiotherapeutists concerning the limitations introduced into operations with high-frequency equipment, and proposed a revision of the problem concerning the advisability of requiring the conduct of therapeutic procedures while working in frequency and screening cabins (booths), designed specifically for medical purposes. He also pointed out the necessity of finding another less expensive and effective method of protection against radio interferences, and in particular, the necessity of designing a simple, convenient and low-cost unit for supersonic therapy under constant and pulse operating conditions.

Engineer A. R. Livenson described the structural characteristics of high-frequency and ultra-high frequency equipment used for therapeutic purposes, and examined the technical requirements imposed on physiotherapeutic equipment. In his report, he called attention to the fact that such equipment is provided with automatic devices making the therapeutic treatment more simple and reliable, and he also stressed the need of expanding the volume of research and design work in the field of high-frequency physiotherapeutic equipment.

In his report, A. S. Presman noted that numerous researchers attribute the biological effect of microwaves exclusively to the formation of heat in the tissues, whereby the parameters of presently manufactured therapeutic equipment are based on this fact. However, research conducted in the USSR has shown that low-intensity irradiation of the body (without causing a sensation of heat) also exerts a noticeable action on the organism. It was noted that pulsed microwaves and microwaves modulated in a special manner are of special interest for physiotherapeutic purposes. For this reason, special wide-range generators allowing a control of output power and the possibility of modulation by an external source are required.

Engineer A. S. Shishkin, after enumerating the frequencies allotted for medical purposes and listing the specified permissible interferences for such frequencies, examined the protective measures used at the present time. He noted that, although the method used for the suppression of interferences in each unit is simple and economical, this method is not capable of suppressing interferences caused by fundamental frequencies, i.e. those frequencies used for medical purposes. On the other hand, the method of suppressing interferences with the aid of screening cabins, although it is more effective, is connected with the use of very complex and expensive equipment; when this method is used, the patient is isolated from medical personnel during treatment.

The speaker showed that the mere use of screening or individual protective measures in each unit is not fully effective. For this reason, he suggested to combat interferences by separating them from harmonics mainly at their point of origin, and to separate interferences from fundamental frequencies at the point of reception. On hand of examples and calculations, it was shown that the realization of the above measures for combating interferences is considerably more advantageous for the government, from an economical and technical standpoint, than the shielding of installations.

Candidate of Technical Sciences M. D. Gurevich, after describing the field of application of supersonic vibrations, noted that the problem concerning the dosage of supersonic energy in therapeutic treatment has not yet been solved. The speaker then examined the dosage methods used at the present time. Specifically, such methods involve the measurement of the pressure of supersonic vibrations directed into water present in a dosage meter. In this connection, it can be assumed, with a very gross approximation, that, under constant operating conditions of the unit, the same power is radiated into the tissues. In addition, dosage meters installed in the unit are now being used. These meters measure the voltage on the radiator, which, under certain conditions, constitutes a measure of the radiated power. Some units are equipped with an indicator showing the audio contact of the radiator with the surface of the skin. The speaker then described the structural design of supersonic generators used in the medical field.

Among the papers presented in other sections, it is interesting to note the report made by Prof. V. B. Babskiy on various data units allowing the recording and measurement of non-electric processes in the organism. V. M. Khayutin described to the participants of the conference the structural design of an interesting electron tube, known as a mechanotron. With the aid of this small tube, the smallest mechanical displacements can be measured and recorded by changing the position of the tube anode. This tube can be used for measuring the blood pressure inside vessels, in heart cavities, and for a large number of other purposes.

Of great interest was the paper read by L. I. Gutenmakher, which described the possible approximate reproduction of certain memory functions with the aid of electronic devices. Electric models of memory can be used in studying the mechanism of human memory, and in analyzing a number of nervous and psychic diseases accompanied by memory disturbances.

In addition to the papers mentioned above, a large number of interesting reports were presented at the conference, but it is not possible to describe them in this article.

Similarly to the speakers, those who took part in the discussions noted that the medical instrument building industry was lagging behind considerably, both from a qualitative and quantitative standpoint, and made a number of suggestions for eliminating this lag and raising the level of knowledge of physicians in the field of physics and technology.

The resolution adopted at the conference noted that the progress achieved in the field of radioelectronics offered exceptionally favorable perspectives for the development of preventive practice (prophylaxis), diagnosis, treatment of diseases and general biological science. The design of the most modern instruments and equipment appears to be a definite possibility. However, this potential is poorly utilized, and the rate of development of medical science, particularly in regard to the application of radioelectronics, is substantially lagging behind present public health requirements and does not permit to fulfill the great tasks confronting the public health system and medical science during the coming 7-year period. The organization of scientific-research and experimental design work in the field of radioelectronic equipment for medical and biological use is quite unsatisfactory.

The conference recommended an intensification of scientific-research and design work in the field of diagnostic and therapeutic equipment, and in the design of equipment used in rapid laboratory analysis methods.

The conference filed a petition with the State Committee for Radioelectronics under the Council of Ministers of the USSR, requesting the organization of a special All-Union Scientific-Research Institute of Radioelectronic Medical Technology and asking that the number of establishments engaged in the design and manufacture of radioelectronic equipment be considerably expanded. The conference also addressed a petition to the Interdepartmental Committee for Radio Parts under the Ministry of Communications of the USSR, requesting that a combined and coordinated program for combating radio interferences be set up, and asking that the limitations on the fundamental frequency radiation of electronic medical equipment within a definitely specified frequency range be eliminated and that the norms of the permissible radio interferences be revised.

A number of measures were outlined, aimed at increasing the output of equipment, at effecting a rapid adoption of new achievements in medical practice, and at improving the training of personnel and the exchange of experience and information.

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